as it is, can be made to rise, fall or rotate by an almost imperceptible movement of the hands, possibly after a time unintentionally on the part of the water-diviner, and the public is impressed. For the same reason it may be well to find that water can only be met with in some inconvenient position, such as under a haystack or the cellar of the house, or the corner arch of a large granary. Ignorant and credulous people will have much more faith in you if you put them to a little inconvenience.

If the water-finders would leave it here, there could be no cause of complaint, provided, of course, that they succeed where geologically trained people fail. But when they put forward preposterous "scientific explanations" such as I have extracted, it makes it very difficult not to come to the almost inevitable conclusion that the water-finder has no case, and that the surcharging of his fees by auditors is necessary for the protection of public bodies. Perhaps among the 130 references in the Bible to the rod, staff or sceptre already referred to is this, "a whip for the horse, a bridle for the ass, and a rod for the fool's back."

C. V. BOYS.

HISTORY OF THE ART OF EXPERIMENTING.

Geschichte der Physikalischen Experimentierkunst. Von Dr. E. Gerland und Dr. F. Traumüller. Pp. 427. (Leipzig: Wilhelm Engelmann, 1899.)

THIS work, illustrated by more than four hundred woodcuts, gives a most interesting account of the apparatus used and of the investigations made by scientific inventors from the earliest times at which records exist down to the invention of Morse's printing telegraph in 1843.

One of the most interesting things that appears on the face of this history is the great mechanical ingenuity of many of the inventors of ancient times, as, for example, Hero of Alexandra, who invented a penny-in-the-slot machine, and the almost entire absence of any attempt to carry out what we would now call an experimental investigation. The experimental investigation of natural phenomena is extraordinarily modern, and the looking for mere rules of sequence in the phenomena rather than transcendental souls, spirits, effluvia, and such like efficient causes, is still more modern. This history covers a period of some four thousand years; but experimental science of the modern type is not more than three hundred years old. It is only amongst scientific men that the nature of experimental inquiry has been appreciated for as long as three hundred years. The well-educated man has not appreciated its nature for more than fifty years, and it is only within the last few years that in Britain the characteristic nature of experimental science has been at all generally understood. Even now a person is considered well educated who does not understand how to learn from experiment and observation to regulate his life. As a consequence, many so-called well-educated persons make awful fools of themselves.

In addition to the history of the subject, there are in connection with each period interesting *résumés* of its peculiarities, and of how it was an advance on its predecessors and yet did not attain to the position of subsequent workers. For example, attention is called to the way in which Gilbert, though in many ways imbued with the modern spirit of experimental inquiry, was still so dominated by the notion that magnets were possessed with some sort of soul or spirit that he cannot be rightly classed amongst the moderns, but is a sort of connecting link between them and mediæval superstitions.

There are two interesting questions that are not solved. One concerns the connection between Archimedes' observation in his bath, the method he employed to discover the amount of alloy in King Hero's crown, and the principle he enunciates in his writings as to the loss of weight of bodies immersed in a liquid. There seems no doubt from the description of the experiments he made (by observing the rise of water in a vessel when gold and silver were immersed in it) that he did not use weighings at all in his determination of the alloy in the crown. It would be interesting to know how he then discovered the amount of loss of weight of a body immersed in a liquid. What set him on observing this? The question is the more interesting in that most of the scientific workers of that age seem to have confined themselves to solving practical difficulties in the way of carrying out some project they had in hand, and were not at all imbued with the modern spirit of experimental research. The other question that needs elucidation is as to the observation of the Florentine Academicians that water could penetrate gold. This experiment used to be very commonly quoted to prove the ultimate porosity of solids, but it does not seem to have been repeated, and there are very grave doubts as to the genuineness of this penetration. It seems much more likely that the gold cracked, and that the Florentines did not observe this.

It has several times happened that all the necessary principles involved in subsequent inventions have been discovered, and attempts made to apply them long before the inventions were brought into actual use. In most cases it seems to have been the want of means or of push of the inventor that prevented him from getting his invention into use. There is a generally received notion that this want of success has been usually due to want of practical ability to get over difficulties that arise in actual use. This seems to have been true to only a very small degree. A very remarkable instance of an old invention coming into use is that of heat engines. Hero of Alexandria invented several forms of heat engine, including that latest development of steam engines a turbo-motor; yet it was only during last century that any serious use was made of them, unless imposing on the worshippers in Egyptian temples can be called a serious use. The rate of evolution of the steam engine has been most remarkable. Invented by Hero, it languished in an amœboid condition for many centuries, and then within two hundred years it developed into its present highly organised family of many genera and species. If a future geologist were to exhume the remains of steam engines, and were to have some means of determining the ages that elapsed between Hero's engines and that of Savery, and from these data were to evolve a chronology of the recent developments, he could hardly avoid concluding that it took at least a million years to develop the engines of a modern steamship from Savery's engine. Many other forms of engine have been proposed. Huygens' gunpowder engine

is a natural parent of gas engines, and it seems possible that some smokeless explosive might be used for driving motor-cars; for though the fuel would be heavy the mechanism might be simple, and the opportunity for varying the work done at each stroke very considerable, so that its adaptability to the circumstances of motor-car propulsion would be great.

The work is so full of interesting matter that it would be hopeless, in a short review, to call attention to the tenth part of its contents. Accounts of Egyptian, Greek, Roman and Alexandrian inventions are followed by accounts of those of the Byzantines, Arabians and of the Middle Ages. Science progressed slowly in these dark ages. Ten pages suffice for the whole of the inventions of Europe for this thousand years. While the energies of mankind were divided between fasting and praying for others, and fighting and preying on others, there was but little time or opportunity for the study of nature. With the sixteenth century the tide of evolution of the means of studying nature had begun strongly to flow. At first rising slowly it has in this last century come like the bore on the Amazon, almost overwhelming us with the rapidity of its development.

G. F. F. G.

OUR BOOK SHELF.

The Diseases of Children. By G. Elder and J. S. Fowler. Pp. xii + 391. (London: C. Griffin and Co., Ltd., 1899.)

FEW things show more clearly the advance made in the practice of medicine within the last thirty years than the way in which the diseases of children are now regarded as compared with the place assigned to them a generation or so ago.

It was thought then that to attend to the common ailments of women and children, those of children especially, was work that scarcely demanded the preparation of a complete medical curriculum. Even a professor of medicine at one of the leading universities had the courage within living memory to say publicly that a two years' course would be quite enough for successful practice "among women and children."

Nowadays all this has changed. It is universally recognised that the physiology and the ailments of men are not a whit more intricate than those of women, and that both are simpler than those of children. To treat young children successfully requires, not only all the training and knowledge every good practitioner ought to posess, but important additions. Some of these additions, moreover, are natural gifts which cannot be acquired by any amount of training or patience. To be able to read a child's nature easily is as much a gift as a fine ear for music. Some men and women have it, and many more are completely without it. To succeed as specialists in children's ailments it is essential not to be without it.

The work before us is intended mainly for students, and one of its aims is to show them how and what to observe. A large part of the book is concerned with the physiology of growth, of nutrition and of the nervous system. Many of the illustrations are specially good.

The sections devoted to the study of diseases of the various systems, digestive, circulatory, &c., suffer from the condensation necessary in a work of this size. It is a hopeless business to try to make pemmican attractive. But, on the other hand, pemmican has its uses, and a book small enough to be carried to the bedside in a hospital ward will often help a student more, for a time, than larger and more interesting works could do. These he will read later and with a mind more ready to appreciate them.

Fowler and Elder's manual will not displace Ashby and Wright's on the same subject, but it is a sound and trustworthy guide in a difficult department of medical practice.

Analyses Électrolytiques. By Ad. Minet. Pp. 170 (Paris: Gauthier-Villars, Masson et Cie, 1899.)

THIS handy volume, which appears as one of the "Encyclopédie scientifique des Aide-Mémoire," affords another indication of the continually increasing application of electricity to chemical analysis. About a third of the book is devoted to the description of apparatus used in electro-chemical analysis and to general considerations of a practical and theoretical nature. The latter contain certain inaccuracies which indicate that the author is not conversant with the advances made during the last decade, in regard to our knowledge of the nature of salt solutions on the basis of the theory of electrolytic dissociation.

The second and third chapters deal respectively with the analysis of metalloids and with the quantitative determination of the metals when present in solutions free from other metals. The fourth chapter treats of the separation and determination of the metals in a mixture; while the last is devoted to a few technical applications, such as the analysis of industrial copper, of bronzes, and of brass.

The practical portion of the book is clearly written; but on account of the lack of details in the case of a considerable number of the analyses, the book can scarcely be recommended to electro-chemical students for use in the laboratory.

Essais des Huiles Essentielles. By Henri Labbé, Ingénieur-Chimiste. Pp. 187. (Paris: Masson et Cie.)

THIS neat little volume, which forms part of the "Encyclopédie scientifique des Aide-Mémoire," published under the direction of M. Leauté, is intended as an introduction to the analysis of essential oils, substances which, according to the author, are very liable to adulteration.

The directions given for analysis are too general and brief to be of real utility to the practical analyst, but the properties of the pure products, compiled from Schimmel and Co.'s publications and from other trustworthy sources, are carefully tabulated, so that the book will at least be serviceable for purposes of reference.

Chemistry for Organised Schools of Science. By S. Parrish, B.Sc., A.R.C.S. With Introduction by Dr. D. Forsyth. Pp. xiv + 262. (London: Macmillan and Co., Ltd., 1899.)

THE course of experimental work described in this volume is designed for students in Schools of Science of the Department of Science and Art during their first two years of study. It is the outcome of experience, and represents the work which pupils from thirteen to fifteen years of age can do and understand. Following the reformed plan of teaching chemistry, the course begins with simple chemical manipulations, weighing, solutions, distillation, the preparation of common gases, composition of water and air, formation of salts, carbon and its oxides and a few organic compounds. In the second year's course easy quantitative experiments are given, and attention is paid to the laws of chemical combination, symbols, formulæ, &c. The halogens, sulphur and its compounds, the estimation of volume, are among other subjects dealt with. The test-tubing exercises, which once formed the chief part of the work of the student of elementary chemistry, are omitted altogether; and in their place we have a rationally constructed course of work, in which the intimate relation between chemistry